Kongeriget Danmark

Patent application No.: PA 2002 01365

Date of filing: 16 September 2002

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Title: A device for administration of drugs

IPC: -

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Patent- og Varemærkestyrelsen
Økonomi- og Erhvervsministeriet

27 March 2003

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PATENT- OG VAREMÆRKESTYRELSEN

A DEVICE FOR ADMINISTRATION OF DRUGS

The present invention relates to a device comprising monitoring means for monitoring taking of a dosage of drugs and comprising means for containing drugs. The term dosage relates to a certain amount of drugs. The term drugs is used both in sense of a medicament and the like and in the sense of any personal hygienic item. The invention relates to devices for improving medical drug therapy, and more particular to improvement of therapies involving oral intake of drugs in the form of tablets contained in packages such as blister cards.

Any of the functions monitoring, registration, reminding, perhaps together with signalling and displaying of compliance in relation to taking of drugs contained in a drug storage device is of importance to a user having to take any kind of drugs and/or to any medical personnel monitoring the compliance of the user. The drugs may be a pharmaceutical drug or a medicament. It may also be other kinds of drugs not being related to any prescription or medication such as nicotine tablets for reducing or supplementing smoking or even other kinds of drugs such as dental chewing gum, or anti-histamine tablets or vitamin pills or the like for promoting health, or still even other kinds of drugs just for enhancing the well-being of the user.

BACKGROUND OF THE INVENTION

Many drug therapies do not have the intended effect due to lack of response to the specific drug taken by the patient or due to insufficient compliance to the prescription. In the primary care section, it is very difficult for a physicist to identify the reason of lack of effect of the drug, because the patient takes the drug at home, and insufficient compliance can arise from a number of reasons. Basically, the physicist is faced by the problem of differing *non-responders* from *non-compliers* if the therapy does not have the intended effect, and it is therefore difficult to decide how to change therapy or patient behaviour. *Non-responders* can only be addressed by changing drug dosage or dosage type. However, *non-compliers* can be addressed in a number of ways by incorporating different kinds of intelligence in devices linked to the drugs, i.e. drug delivery devices.

DE 195 44 294 describes a very expensive method of monitoring compliance, as it exploits custom blister cards with conducting wires. This increases the cost of the blister card, but also the risk of introducing technical weaknesses that the patient will have to take care of, i.e. unintended breaking of conducting wires or insufficient electrical contact between blister card and device.

US 5,313,439, WO 02/24141 and other prior art patent literature related to reminding are only addressing the reminding problem, which possibly may improve the compliance, but it can never be used as decision support for the physicist or other medical personnel, or as a motivation for the patient. Further, such prior art has the huge disadvantage that the patient is reminded only a predetermined period after a previous drug intake. This is not suitable for a real life situation, as the reminding will take place according to daily habits, but dependent on last tablet taken.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a device which is capable, in a manner not depending on the supervision of medical personnel, to monitor when drugs are taken by a patient, alternatively to remind a patient of when drugs should be taken. Thus, basically the object is to trust the patient taking the drugs, perhaps according to a drug dosage plan, and the monitoring of taking of drugs depending on the actual behaviour of the patient and not solely, but perhaps additionally, depending on a preferred behaviour of the patient.

This object may be obtained by a device for administration of drugs, said drugs being tablets contained in the device, and said device establishing a mutual state between the drugs contained in the device and the device itself, said mutual state at least comprising a first state and another state, said first state being a state where taking of tablets is inhibited, and said other state being a state where taking of tablets is possible, said device further comprising monitoring means intended for registering at least that the drugs and the device itself is in the first mutual state, preferably also intended for registering, when the mutual state between the drugs and the device itself changes from the first state to the other state.

In a simple, yet reliable manner, the mutual state between the drugs and the device will be indicative of when drugs are taken. No certainty, as may be the case with prior art devices, are obtained, the change in mutual state neither implying that a drug dosage is taken, nor implying that the correct drug dosage is taken. However, the monitoring take the basis in trusting that the patient, when changing the mutual state, does take a drug dosage, and that the drug dosage taken is the correct drug dosage, perhaps according to a drug dosage plan.

In a preferred embodiment, said monitoring means are also intended for registering at least when the drugs and the device itself is in the second mutual state, preferably also

intended for registering when the mutual state between the drugs and the device itself changes from the other state to the first state.

By not only monitoring when the mutual state changes from the first state to the other state, but monitoring also when the mutual state changes from the other state to the first state, a more reliable monitoring may be accomplished, because of the possibility of monitoring for how long the other state, where drugs may be taken, is present.

Preferably, the drugs contained in the device are contained in a drug package, i.e. they are not loosely contained in the device, and even more preferred the drug package is a blister pack, i.e. the drugs are not loosely, but individually, contained in the drug package.

According to an embodiment of the invention, the device also comprises means intended for informing of a state of compliance, said informing depending on whether compliance is present or not, and said informing means being active at least when compliance according to the drug dosage plan is not present. A state of compliance may either be non-compliance or compliance, i.e. differentiating only between no compliance and 100% compliance. The state of compliance may also be a level of compliance, thus differentiating between certain percentages of compliance in relation to 100% compliance.

The informing may take place by notifying to the visual sense of the patient, by notifying to the auditory sense of the patient, or by notifying to the tactile sense of the patient.

One way of visualising a state of compliance may be signalling being active and thereby directly signalling one state when compliance according to the drug dosage plan is not present, and said signalling means instead being inactive and thereby indirectly signalling another state when compliance according to the dosage plan is present.

Another way of visualising a state of compliance may be signalling being active and thereby directly signalling one state when compliance according to the drug dosage plan is not present, and said signalling means also being active, and thereby also directly signalling another state when compliance according to the dosage plan is present.

A third way of visualising a state of compliance may be a display means directly displaying a number of levels of compliance, when a certain level of compliance according to a drug dosage plan is not present, and said display means directly displaying a number of other levels, when compliance according to the drug dosage plan is present.

A fourth way of visualising a state of compliance may be a display means indicating to the user of the device that one level of compliance according to the drug dosage plan is not present, that another level of compliance according to the dosage plan may possibly be established instead of the one level of compliance, said indication of the other level of compliance possibly being established, when the drugs to be taken have not been taken, but when the drugs according to the drug dosage plan may still be taken for thereby establishing at least the other level of compliance according to the drug dosage plan.

According to one embodiment of the device according to the invention, the device comprises reminding means for reminding a user of an absolute moment of time for taking drugs, said reminding means comprising a number of the signalling means: visually, audible and tactile signalling for reminding the user, and said signalling means preferably being differentiated according to a chosen state of compliance of taking the drugs.

According to another embodiment according to the invention, the device comprises reminding means for reminding a user of a relative moment of time for taking drugs, said reminding means comprising a number of the signalling means: visually, audible and tactile signalling for reminding the user, and said signalling means preferably being differentiated according to a chosen state of compliance of taking the drugs.

A differentiation may be made between an absolute moment of time and a relative moment of time for reminding the patient of when to take a drug dosage. An absolute moment of time is a time according to the clock. A relative moment of time may be a moment of time calculated according to when a drug dosage plan is initiated, the initiation of a drug dosage plan perhaps being when a blister card is inserted into the device for the first time. A relative moment of time may also be a moment of time calculated from the time when a drug dosage was lastly taken.

According to a preferred embodiment of the device, the device is capable of recording an information related to the drug, said information comprising a number of the following kind of information: Information on the type of drugs in the device, information on the manufacturer of the drug in the device, information on the initial amount of drugs in the device, and information related to a drug dosage plan.

By proving any of the above information it will be very easy for the patient or the medical personnel to assure a proper and correct usage of the device in relation to the drug contained in the device. The device may thus monitor the taking of drugs in relation to a number of different kinds of information, each establishing a more qualitative taking of drugs than if none of the above kinds of information is assigned to the taking of drugs.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following, the invention will be described with reference to the accompanying drawing, where

fig. 1A-1F are drawings of a possible first embodiment for a device according to the invention, and with means for monitoring the position of a blister card,
fig. 2A-2G are drawings of a possible second embodiment of a device according to the invention, and with means for monitoring the position of a covering part, and
fig. 3 is a sketch of a possible alternative embodiment of a device according to the invention, said embodiment comprising additional means for the administration of drugs,
fig. 4A-4B are timelines showing possible ways of administering drugs utilising the device according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1A-1F show a first embodiment of a device for holding a blister card 1. In fig. 1F, the device is shown with a blister card 1 inserted into the device. The device has a closed surface 2 and oppositely thereto a partly open surface 3. The partly open surface 3 has a slot 4 extending partly down the surface. The slot 4 is intended for inserting a finger for sliding the blister card into and out of the device. The one end 5 of the device has an inlet 6 for inserting the blister card into and taking the blister card 1 out of the device. The other end of the device has monitoring means (not shown) for registering the position of the blister card.

The monitoring means is intended for registering a first position of the blister card within the device, said first position being a position where the blister card is fully or almost fully inserted into the device. Fully or almost fully inserted is a position where the closed surface 2 covers all of the tablets in the blister card 1, so that not even one tablet can be taken from the blister card.

The monitoring means is preferably also intended for registering another position of the blister card in relation to the device, said other position being a position where the blister card is fully or partly pulled out of the device. Fully or partly pulled out is a position where the closed surface 2 does not cover the tablets in the blister card 1, or at least does not cover outer tablets in the blister card, so that at least one tablet can be taken.

In the embodiment shown the device also comprises a small signalling means 7 such as an LED or other lighting means placed in another end 8 of the device. The signalling means 7

may have different functions. The signalling means may be for signalling to the user when the blister card is in the first position or not, i.e. in the position, where tablets cannot be taken from the blister card.

The signalling means may also be a means for reminding the user of when to take a tablet according to information from a dosage plan stored in an electronic memory (not shown) of the device. The signalling means may also be a means for displaying to the user a level of compliance. A first level may be a level of compliance where the dosage of tablets to be taken and the time at which the tablets are to be taken have been fulfilled according to the dosage plan. In this situation the signalling means may show a steady green light. A second level of compliance may be a level of compliance, where the dosage of tablets to be taken and/or the time at which the tablets are to be taken, have not been fulfilled according to the dosage plan, but where satisfactory compliance still may established if the dosage of tablets are taken. In this situation the signalling means may show a steady yellow light. A third level of compliance may be a level of compliance where the dosage of tablets to be taken and/or the time at which the tablets are to be taken, have not been fulfilled according to the dosage plan, and where satisfactory compliance cannot be established, even if the dosage of tablets are taken now. In this situation the signalling means may show a blinking red light, or a steady red light. Other ways of signalling may be established depending on other defined intermediate levels of compliance according to the information of dosage plan stored in the device.

The device is designed so that the closed surface 2 and the opposite surfaces 3 are curved. This has the advantage that when the blister card 1 is inserted through the inlet 6 into the device, the blister card will be slightly bent compared to the planar configuration of the blister card before insertion into the device. The slight bending of the blister card will lead to the blister card being wedged in the device, thereby holding the blister card in the device without any elements as such for holding the blister card within the device.

Thus, when the blister card is inserted into the device through the inlet and is pushed all the way to the first position where the blister card is fully inserted in the device, then the blister card cannot drop out of the device. The curvature of the closed surface and the partly open surface may have any rise H of the curvature in relation to a length of the blister card. The only demand of the rise H of the curvature is that the blister pack must be so hardly wedged as not to drop out of the device by accident, perhaps when the inlet of the device is directed downwards.

The device is also so designed that the one end 5 and the other end 6 of the device have flattened parts 9. The flattened parts 9 enable the placement of the device at a supporting

surface such as a table. The device also has a shape and a size making it possible easily to bring the device along during the day, either in a bag, even a small lady's handbag, or in a pocket of a shirt or of a pair of trousers. The size of the device is not much larger than the size of the blister card contained in the device. Thus, the device itself will not be limiting the compliance of the user, only the "discipline" of the user will determine the compliance.

Fig. 2A-2G show a second embodiment of a device for holding a blister card. In fig. 2G, the device is shown with a blister card 1 inserted into the device. The device has a movable covering part 10; in the embodiment shown, a hinged covering part. In an alternative embodiment, the covering part may be slidable along grooves in the device in stead of being tipped around a hinge such as shown. In an even alternative embodiment, the covering part may just be liftable from a lowered closed state on top of the device to a raised open state separated from the device.

The covering part 10 is intended for covering a compartment 11 for holding the blister card within the device. In an open state of the covering part 10, both the compartment 11 and control buttons 12 of the device are covered. In the embodiment shown, the covering part 10 has an aperture 13 for allowing viewing of a display 14, even if the covering part 10 is in the closed state. A small signalling means 15 is situated to the right of the covering part 10, and the covering part 10 does not cover this signalling means 15 either, even if the covering part 10 is in the closed state.

As mentioned above, in the embodiment shown the device also comprises a small signalling means 15 such as a LED or other lighting means such as the one shown in the first device of fig. 1A-1F. The function and purpose of the signalling means 15 of the second embodiment shown in fig. 2A-2G may be any one of the same purposes and functions as the ones described in relation to the first embodiment. Accordingly, the description related to the first embodiment of fig. 1A-1F regarding the function and the purpose of the signalling means is hereby, by reference, incorporated into the description of the signalling means of the second embodiment shown in fig. 2A-2G.

Apart from the signalling means 15, as mentioned, the second embodiment of the device also has a display 14. The display 14 may be used for many purposes and may include different functions. A display increases the amount of and the kind of information which may be given to the user apart from the information given by the previously described signalling means 15. Also, apart from the display 14, as mentioned, the second embodiment of the device has control buttons 12. Control buttons 12 may be used for different purposes. The control buttons 12 may be used for entering data into an electronic

memory of the device. The control buttons may also be used for scrolling between different data or different sets of date, all capable of being shown in the display 14.

A bottom part 16 of the device shown in fig. 2A-2G is provided with holes 17 intended as outlets for tablets from the blister pack 1 contained in the compartment 11 of the device. The outlets 17 may have an orifice 18 planar with surface 19 of the bottom part 16. This will however necessitate holding the device in the hands of the user, when having to dispense one or more tablets from the blister pack in the compartment.

Therefore, in an alternative embodiment of the device, the outlets may have an orifice 18 being situated at a level above a level of the bottom surface 19. This leads to the advantage that the device may be placed at a supporting surface such as a table, when dispensing the tablets from the blister pack. In order for this function to be realised, the level at which the orifices of the outlets are situated must be situated above the level of the bottom surface in a distance being the same as or larger than a height of the tablets to be dispensed.

Thus, due to the possibility of orifices of the outlets situated in a plane above a level of the bottom surface, and thus above the supporting surface, there is room for the tablets between the orifice of the outlets and the supporting surface, when the device is placed with the bottom surface on the supporting surface. Being able to place the device on the supporting surface when dispensing the tablets, makes it very much easier to dispense the tablets from the blister pack, especially for elderly people or others having only a limited amount of strength in hands and fingers.

The bottom surface has a small cover 20. This cover is intended as cover for batteries for powering the signalling device, the display and any electronic memory storage means of the device. The batteries may also be used for powering possible means for transmitting data from the device or receiving data to the device from to a remote data receiving or data transmitting apparatus for storing, or in any other way handling data related to the usage and the monitoring facilities of the device.

The one side of the device has a plug 21. One or more plugs may be provided for different purposes. One purpose of a plug may be to provide the device with electrical power from an external power source, either as an alternative to the batteries, or as a supplement to the batteries. Another purpose of one or more plugs may be to provide the device with a wired link to an external data receiving and/or data transmitting apparatus. The number of plugs may also be intended for a telecommunication means such as modem or the like for providing the device with a wireless link to an external data receiving and/or data

transmitting apparatus. Finally, the plug may be used for transmitting data to other devices related to the use of the device according to the invention, such other devices perhaps being a sound alarm, a lighting alarm or a tactile alarm in the vicinity of the device and of the user and having the purpose of alerting the user of when to take a tablet from the device in order to maintain or in order to obtain satisfactory compliance.

Monitoring the actual direct status of the dispenser and monitoring the compliance may take place by any suitable means. The display may, as shown in fig. 2, constitute a part of the dispenser. However, alternatively the display may be connected to the dispenser either physically by a permanent or detachable wiring, or non-physically by means of wire-less signals either to a separate display unit or perhaps to a mobile phone, or any other means of receiving wire-less signals.

Using wire-less signals to transmit the monitoring of compliance has the advantage that means for receiving messages that may be more frequently used than the dispenser, such as a mobile phone, will constitute the display means. This will increase the safety of the user taking the tablets at the prescribed times of drugs, and thereby maintain proper compliance. Furthermore, it will be possible for others than the user to monitor the compliance of the user, perhaps a doctor or other supervisor related to the dosage plan.

At least the device shown in fig. 1, and possibly also the device shown in fig 2 may be provided with a mechanical switch which is engaged when a blister card is stored in the device. Referring to the embodiment shown in fig. 1, when the blister card is removed from the first position, the switch is disengaged, this being monitored by a timer in the device. When the blister card is moved to the first position again, the timer monitors this as a dosage of drugs having been taken.

In a possible functionally extended embodiment, the timer may compute when the next dosage of drugs has to be taken according to a drug dosage plan, and the user may be reminded according to this drug dosage plan. When the switch is disengaged again, this is monitored as the blister card having been removed from the first position, and compliance having been fulfilled if the removal complies with the drug dosage plan.

To avoid a user to achieve a misleading good compliance by pulling the card from and to the first position a number of times, the removal of the card could be registered as a tablet taken, only if it happens during an active alarm. This reduces the risk of a misleading compliance indication by failed operation, and makes it more cumbersome to cheat the device. This way of detecting the consumption of tablets is rather simple and inexpensive,

but still relatively reliable and valuable as a new tool to optimise a treatment, and enable distinction between non-compliers and non-responders.

Referring to the embodiment shown in fig. 2, the same functionality as above may be incorporated in a functionally extended embodiment. However, the monitoring is not a monitoring of a removal of the blister card, but is a monitoring of lifting the covering part from the first and closed position to another and open position. In this way, exactly the same function as described above with reference to the embodiment of fig. 1 may be obtained just by monitoring the covering part in stead.

Alternatively to a mechanical switch used for monitoring at least when the blister card or the covering part is in the first position or not, other means of monitoring could be used. Thus, a capacitive monitoring may be used where the blister card or the covering part introduces a change in a capacitor, when being placed in the first position compared to not being in the first position. Also magnetic means or optical means may be used to monitor when the blister card or the covering part is in the first position or not. Additionally, seeing that the blister card often have a back foil made of aluminium foil or perhaps another metal foil, electrical means sensing a conductivity of the foil of the blister card may be used to monitor whether the blister card is in the first position or not.

Fig. 3 is a sketch showing a technically and functionally more sophisticated embodiment of a device according to the invention and being a device for holding a blister card containing the drugs. Additional to being a device for a blister card, the device also is intended for holding a smart card 22. Preferably, both the blister card 1 and the smart card 22 are the size of a credit card according to ISO-standard 7810. Thereby it is easy and likely for the user to bring the device along with other daily use items such as a wallet, a mobile phone and perhaps a credit card holder which may have the size for also holding the device shown in the figure. The device has two pairs of inner slots 23, 24 along side edges 25 of the holder, one pair of slots 23 for taking up edges of the blister card, and another pair of slots 24 for taking up edges of the smart card.

The smart card is provided with intelligent computing means comprising a timer capable of monitoring pre-set time intervals and preferably, but not necessarily, comprising signalling means 26 capable of reminding a user of when to take any drugs, through a small hole 27 in the device. In a preferred and the shown embodiment, the smart card is provided with three tabs 28 each provided with a number, either 80, 85 or 90. These numbers indicate three ways of computing the level of compliance, the numbers indicating the percentage of compliance compared to 100% compliance. Depending on the drugs to be taken, on the user having to take the drugs, and on other conditions related to the drugs, the

compliance may be chosen among the numbers of the tabs. If the compliance level must be as example above 85%, then the tab with the number 85 is torn off before usage, and then the smart card will compute the time intervals and the reminding function according to a 90% compliance level. By setting own target compliance, the user is more motivated to reach the level defined as a good or satisfactory compliance.

Alternatively to having a separate smart card with encoding of compliance level and of the time intervals and absolute and/or relative start time and time for delivering drugs, then the blister card itself may contain all or some of these features. Basically, the coding may encompass a recognising means being a mechanical fit or an optical fit between the blister card itself and a corresponding mechanical or optical fitting to the device.

The mechanical fit as a recognising means may be a special design feature of the blister card and a corresponding design feature of the device, so that it is not possible at all to position the blister card in the first position, if the mechanical fit cannot be established. The mechanical fit may be correlated to a design feature provided as part of the blister card, or the mechanical fit may be correlated with the overall design and shape of the blister card itself. Perhaps the blister card may be provided with a coding intended for a chosen drug dosage plan, said coding being selected by the user initial to introducing the blister card in the device. One of a number of possible mechanical fits may be indicative of the coding chosen by the patient, such as shown in fig 3, where different levels of 85%, 90% and 95% compliance may be chosen by breaking off the one tab indicative of the level chosen. In fig. 3, the breaking off of the tap is used for electronic coding, however similarly, breaking off of one tab may be used for mechanical coding.

The optical fit as a recognising means may be a an optically readable feature of the blister card and a corresponding optical reader of the device, so that it is not possible at all to gather any information form the blister card as to a dosage plan, if the optical reader of the device cannot read a corresponding optical readable feature of the blister card. The optical fit may be correlated to perforations, a breaking off of a corner of the blister pack or the like physical entities of the blister card, or the optical fit may be an optical entity such as a hologram, a certain printing, a bar code or the like. Perhaps the blister card may be provided with a coding intended for a chosen drug dosage plan, said coding being selected by the user initial to introducing the blister card in the device. One of a number of possible optical features fits may be indicative of the coding chosen by the patient, similarly to the more mechanical feature shown in fig 3, where different levels of 85%, 90% and 95% compliance may be chosen, however optically by perhaps providing a hole at a chosen location of the blister card, and a corresponding reader such as a photo cell provided in the device. In fig. 3, the breaking off of the tap is used for electronic coding,

however similarly, the photo cell recognising light through a hole in the blister card may be used for optical coding.

Thereby, the smart card may be superfluous. Any coding of the blister card itself may be more directly related to the drugs, the number of tablets contained in the blister card and other conditions which are essential for proper and correct drug administration of the drugs in the blister card in question. The holder for the blister card may still be like the one shown in the figure apart from the inner side edges of the holder only having one pair of grooves for just holding the blister card. The device may also be a device as shown in fig. 1 incorporating the technical advantages of this device such as the curvature holding the blister card in the device.

An embodiment and functionality as the one described above, where the blister card itself is provided with encoding may be beneficial for a manufacturer of drugs in blister cards, because the manufacturer before handing over to the user the drugs in the blister card can be sure of the encoding ensuring a proper compliance if complied with. Thus, the manufacturer does not have to rely on a doctor or other exterior medical personnel coding the device with the risk of wrongful coding of the device.

As mentioned, perhaps the encoding of the blister card may be made by means of visually or electronically readable and tamper-proof means such as a hologram, a perforation or a small electronic circuit resembling or in any other way utilising trademarks solely used by the manufacture. Thereby, it will be not be possible to use drugs and blister cards from other manufacturers. Also, the user can be sure that the drugs in the blister card and the encoding with a drug dosage plan are mutually compatible, and that the drugs, if taken according to the drug dosage plan, will ensure proper compliance according to the prescribed manufacturer of the drugs. Even alternatively, the blister card may be provided a special design only used by the manufacturer, and having the same purpose of individualisation as described above.

Also as mentioned, another alternative way of implementing variable compliance targets for the users would be to implement the break-off tabs on the device itself. This means that the device is manufactured to reward a certain compliance. After a while, the user can set higher targets by breaking off tabs, which will cause the device to give rewards at a higher level of compliance.

All the devices shown may have one or more signalling means capable of reminding the user of taking the drugs either by a visual, an audible or a tactile signal. The visual signal is a lamp lighting red or other colour, when the time for delivering the drugs arises. The

audible signal may be a siren sounding a warning-like signal. The siren may be adjustable, both in relation to the sound level and in relation to the sound produced. The sound produced may also differ depending on when the drugs is taken along a time interval after the time of delivering has been reached. At the beginning of the time interval, after the time of delivering has been passed, the audible sound is "pleasant" and/or at a low level. As long as the drugs is not taken and depending on how long time after the time of delivering that the drugs is still not taken, then the audible sound will be less "pleasant", i.e. it will start being more alert-like or alarm-like, and/or the audible sound level will increase either stepwise or gradually. The sound may be a beeping sound or it may be a recording of a voice or an exclamation.

Such an adaptive reminding could also be implemented with visual alarming means, such as light emitting diodes, where a flashing pattern changes over time, as the interval since the start of the alarm gets longer. The light produced may also differ depending on when the drugs is taken along a time interval after the time of delivering has been reached. At the beginning of the time interval, after the time of delivering has been passed, the light could be a flashing green light, different from a steady green light, or an alternating green and yellow flashing.

As long as the drugs is not taken and depending on how long time after the time of delivering that the drugs is still not taken, then the light could change to alternating yellow and red flashing and further to a constant and steady red light perhaps even to a flashing red light. The light could be a single light with the above-mentioned pattern of alarming, or it could be a plurality of lights each having their distinct colour and either not lighting or lighting steadily or flashing depending on the level of compliance at a certain time, either during or after the drugs should have been taken according to a drug dosage plan stored in a memory of the device. If the device, as shown in fig. 2, is provided with a display, the level of compliance may also or in stead be displayed by for example a percentage.

In the latter case, either a voice or an exclamation, the sound may be added some humour or a command-like tone so that the sound is personalised in relation to the user utilising the device for taking drugs. By personalising the sound, then the initiative for taking the drugs may be increased. If the sound is a voice it may the voice of a doctor, preferably the user himself or the user's own doctor, motivating the user to take the drugs, and the command being more and more harsh along with the drugs not being taken after the time of delivering has been exceeded. If the sound is added humour it may be one exclamation at the beginning of the time interval, after the time of delivering has been exceeded, and being another exclamation late in the time interval if the drugs are still not taken.

Any personalised voice and command or any personalised exclamation which the user chooses will add to the personalising of the device, and thus to impel to handle the device and the taking of the drugs seriously. Such sounds could also be attached to the achieved compliance, so that a good compliance causes a positive or rewarding sound to be played and a poor compliance causes a motivating sound to be played.

Fig. 4A-B shows how drugs could be administered with a device according to the invention, and it visualizes the different administration rules a device is capable of supporting. Basically, a prescription of medicine for example from a doctor to a patient comprises a specification of a drug to be taken and an ideal dosage of the drug to be taken at a certain moment of time, or within a certain time interval. The dosage is related to a certain dosage of drugs (e.g. two tablets) with a certain interval (for example every 24 hours). Therefore the administration is related to a calendar (100), where a number of ideal dosages (110) should be taken at a certain moment of time during the day or within a certain time interval during the day.

In the example shown, the patient is supposed to take one tablet every day at 8 AM. If this administration scheme is followed precisely, the patient compliance is at a maximum. Deviations from the ideal scheme can be interpreted as varying lack of, or a decreased level of compliance. The purpose of the device according to the present invention is to monitor this compliance by application of different rules dependent on the actual function of the relevant drug. Further, the purpose of the device according to the invention is to improve the compliance, both by providing the patient with information about the actual level of compliance and by reminding the patient when to take the drug in order to maintain a certain level of compliance.

The total time can by way of example be subdivided into two main categories, described in the following. Allowed periods (117): The patient is allowed to take a dosage. The period starts at or before the ideal dosage time or reminding time. It seizes when a dosage is taken, when all previous dosages have been taken, or when the next ideal dosage is close-by. Prohibited periods (118): The patient is not allowed to take a dosage. The purpose of the prohibited periods is to avoid over-dosage or to avoid risky high drug concentrations within the patient. The prohibited period starts when a dosage is taken, when the right average dosages have been reached, or when the next ideal dosage is close-by. It seizes when a new ideal dosage is close-by. These periods can be divided into a number of relevant sub-periods for more detailed monitoring information.

For example, this more detailed information could be: Early intake (125), ideal intake (126), delayed intake (127), intake prohibited (caused by dosage taking), next dosage

prohibited (128) etc. The number and the kind of sub-periods depends on the therapy, the kind and amount of drug and on the patients, and might be related to any relevant information in relation to timing of dosages or use of the device.

The term "allowed" and the term "prohibited" refer to periods of time of a drug dosage plan. Allowed is when drug intake according to the drug dosage plan is recommended, i.e. where drug dosage should take place in order to obtain a certain state or a certain level of compliance according to the drug dosage plan. Prohibited is when drug intake according to the drug dosage plan is not recommended, i.e. where drug dosage, if taking place, perhaps will lead to over-dosage, or where drug dosage, if taking place, perhaps will lead to an incorrect follow-up of the drug dosage plan, and a non-existent possibility of re-establishment of compliance according to the drug dosage plan.

The allowed and prohibited periods (117, 118) are the default status of the device. However, dependent on the patient's interaction with the device, the device can change its actual status. For example, the prohibited period (130) is initiated by the device activation (131), as the device is trying to make the patient follow the rule that tablets should not be taken too close to each other in order to avoid too high drug concentration, i.e. a over-dosage. The prohibited period (135) is initiated by the default status, as the dosage was not taken in the allowed period and the next alarm is approaching. The device activation (136) is therefore causing a warning signal (121).

The device can be programmed with the dosage information and can therefore remind the patient at or linked to the ideal dosage time. This is done by a reminder or an alarm (120), which informs the patient that it is time to take the prescribed dosage. An alarm can continue to be activated until a dosage is taken, or it can be cancelled or change from an audio signal to a visual signal after a certain period of time. In the example shown, the alarm is cancelled either by an activation of the device (blister card is taken out or the covering of the device is lifted), or because the allowed period ends and the device enters a prohibited period, where dosage taking is not recommended, because the next alarm is coming soon. If the device is activated in a prohibited period, the device could give the patient an acoustical warning signal (121, 122, 123) indicating that it is not recommended to take a dosage.

Dependent on the function of the drug taken, different rules for administration can be relevant. Events that influence the way of administration could for example be the time before the active substance in the tablet is transferred from the tablet to the blood, the time before the active substance is influencing the relevant site in the body, the half-time period of the active substance etc. If the consequences of a high concentration of drugs

within the patient is harmless and/or the half-time period is longer than the period between taking of drug dosages, the timing is relative uncritical, and good compliance is achieved by taking, in average, the acquired number of dosages. For example, it may be acceptable to take two dosages at the same time if the previous dosage was forgotten. A device for such drug could therefore add up the number of reminders, so that previously forgotten dosages still are reminded to the patient.

For drugs with a very critical upper limit of active substance concentration, for example drugs for anticoagulation treatment, other rulers might be implemented in the device. In this example, the device will give the patient a warning if a dosage is taken too close to the previous dosage taken, or too close to the next ideal dosage to be taken.

CLAIMS

1. A device for administration of drugs, said drugs being tablets contained in the device, and said device establishing a mutual state between the drugs contained in the device and the device itself, said mutual state at least comprising a first state and another state, said first state being a state where taking of tablets is inhibited, and said other state being a state where taking of tablets is possible, said device further comprising monitoring means intended for registering at least that the drugs and the device itself is in the first mutual state, preferably also intended for registering when the mutual state between the drugs and the device itself changes from the first state to the other state.

2. A device according to claim 1, said monitoring means also being intended for registering at least when the drugs and the device itself is in the second mutual state, preferably also intended for registering when the mutual state between the drugs and the device itself changes from the other state to the first state.

3. A device according to claim 1, said drugs being tablets contained in a package, and said device having means for holding the package, said holding means being able to hold the package in at least two positions, a first position defining the first mutual state where taking of tablets is inhibited, and another position defining the other mutual state where taking of tablets is possible, said device further comprising monitoring means in connection to said holding means, said monitoring means intended for registering at least when the package is in the first position.

4. A device according to claim1, said drugs being tablets contained in a package, and said device having means for holding the package, said device comprising a movable covering part with at least two positions, a first position defining the first mutual state where taking of tablets is inhibited, and another position defining the other mutual state where taking of tablets is possible, said device further comprising monitoring means in connection to said movable covering part, said monitoring means being intended for registering at least, when the movable covering part is in the first position.

5. A device according to any of claims 1-4, where said drugs are tablets contained in a blister pack, and said device capable of at least registering the moment of time when the blister card is removed from the first position to the other position, alternatively when the covering part is moved from the first position to the other position.

6. A device according to any of claims 1-5, where the device also comprises means being intended for storing the moment of time when an dosage of drugs is taken, said taking of drugs being correlated to the moment of time when the mutual state between the drugs and the device itself changes from the first state to the other state, and said means for storing comprising a number of the storing means: local electronic storing means, foreign electronic storing means being wired connected to the registration means, foreign electronic storing means being wireless in connection with the registration means.

7. A device according to claim 6, where said additional monitoring means is capable also of registering and storing the actual dosage of drugs being taken, each time a registration is made of a moment of time of taking a dosage of drugs.

8. A device according to any of claims 1-7, said monitoring means intended for at least monitoring whether compliance according to a drug dosage plan is not present, and where compliance not being present is registered when the mutual state between the drugs and the device itself does not change from the first state to the other state at a moment of time, when drugs according to the dosage plan should have been taken.

9. A device according to any of claims 1-8, said monitoring means also intended for monitoring whether compliance according to a drug dosage plan is present, and where compliance being present is registered when the mutual state between the drugs and the device itself does change from the first state to the other state at a moment of time, when drugs according to a dosage plan has been taken.

10. A device according to any of claims 1-9, said monitoring means monitoring only within an allowed period of time, and said monitoring means not monitoring within a prohibited period of time.

11. A device according to any of the preceding claims, where the device also comprises means intended for informing a state of compliance, said informing preferably depending on the level of compliance.

12. A device according to any of claims 1-11, where the device also comprises means intended for warning of intake of a dosage of drugs, said warning means depending on whether an allowed period of time or a prohibited period of time is pending, said warning means intended for warning, within the prohibited period of time, that intake of a dosage of drug is not allowed.

13. A device according to any of claims 1-12, said device being capable of establishing an allowed period where the patient is allowed to take a dosage, and a prohibited period, where the patient is not allowed to take a dosage, said allowed period starting at or before an ideal time of dosage, alternatively starting at an ideal time of reminding, and said prohibited period starting at one of the following moments of time: when a dosage is taken, when the right average dosages have been reached, or when the next ideal dosage is close-by, and said prohibited period seizing when a new allowed period is close-by.

14. A device according to claim 13, said device dividing the allowed period and the prohibited period into at least a number of the following sub-periods: Early period of intake being an intake before the allowed period of intake, ideal period of intake being an intake within the allowed period of intake, delayed period of intake being an intake after the allowed period of intake, but before a prohibited period of intake, and prohibited period of intake being an intake after the allowed period of intake, and after the delayed period of intake, and until a new and subsequent early period of intake.

15. A device according to any of the preceding claims, said device comprising reminding means for reminding a user of an absolute moment of time for taking drugs, said reminding means comprising a number of the signalling means: visually, audible and tactile signalling, for reminding the user, and said signalling means preferably being differentiated according to a chosen state of compliance of taking the drugs.

16. A device according to any of the preceding claims, said device comprising reminding means for reminding a user of a relative moment of time for taking drugs, said reminding means comprising a number of the signalling means: visually, audible and tactile signalling, for reminding the user, and said signalling means preferably being differentiated according to a chosen state of compliance of taking the drugs.

17. A device according to any of the preceding claims, said device comprising monitoring means, and optionally also a signalling means or display means, for at least monitoring, and optionally also signalling or displaying, the amount of drugs in a drug package contained in the device, said monitoring capable of establishing one or more of the following situations: when no drugs have yet been let out of the drug package, when an amount, but not all, of the drugs has been let out of the drug package, and when all of the drugs have been let out of the drug package.

18. A device according to claim 17, said display means furthermore being capable of displaying one or both of the following situations: The amount of drugs left in the package

in the device when drugs still are present in the package, and that no drugs are left in the package when all drugs have been let out of the package in the device.

19. A device according to any of the preceding claims, where the device is capable of recognising an information related to the drug, said information comprising a number of the following kind of information: Information on the type of drugs in the device, information on the manufacturer of the drug in the device, information on the initial amount of drugs in the device and information related to a drug dosage plan.

20. A device according to claim 19, where the information is provided separate to a drug package by providing an information carrier, when the drug package is contained in the device, is separate to the part of the drug package containing the drugs, and said information carrier also intended for being contained in the device itself together with the drug package.

21. A device according to claim 19, where the information is provided integrate with a drug package by providing an information carrier when the drug package is contained in the device, is integrate with the part of the drug package containing the drugs, and said information carrier also intended for being contained in the device itself as part of the drug package.

22. A device according to any of the preceding claims, said drugs being tablets contained in a blister pack, said device having means for holding the blister pack, and said device having a pocket-like structure with an inlet for passing the blister pack into and out of the device substantially along a longitudinal direction of the device

23. A device according to claim 22, said device having a curved cross section seen substantially perpendicular to the longitudinal direction, and the curved section bending the blister pack when the blister cars is passed into the device, said bending resulting in a biasing of the blister pack in the pocket-like structure for thereby holding the blister pack.

24. A device according to claim 22 or claim 23, where the device has a partly open surface, said partly open surface having a slot running at least along part of the longitudinal direction of the device, said slot being intended for inserting a finger and by means of the finger for sliding the blister card into and out of the device trough the inlet of the device.

25. A device according to any of the claims 1-21, said drugs being tablets contained in a package, preferably contained in a blister pack, said device having means for holding the

package, said device having a compartment for holding the package and having a covering part intended for covering the compartment, said covering part being movable from the first position being a closed state inhibiting access to the compartment to another position being an open state allowing access to the compartment.

26. A device according to claim 25, said drugs being tablets contained in a package, preferably contained in a blister pack, said device having means for holding the package, said device having a bottom provided with a number of outlets, the number of and a position of the outlets being provided according to a number of and a position of tablets in a drug package intended to be held in the device.

27. A device according to claim 25, where said outlets in the bottom of the device have orifices being provided at a different level than a bottom surface of the bottom itself, and that a distance between the level of the outlets and the level of the bottom surface is at least the same as, preferably larger than, a dimension of the tablet in the package intended to be held in the device, said dimension of the tablet being viewed in the direction of a push-out of the tablets from the device through the outlets.

28. Use of a device according to any of claims 1-27 for at least monitoring the dispensing of drugs from a drug package being contained in the device, preferably for monitoring the dispensing of tablets from a blister pack in the device.

29. Use of a device according to any of claims 1-27 for at least informing of the dispensing of drugs from a drug package being contained in the device, preferably for informing of dispensing of tablets from a blister pack in the device.

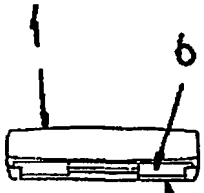

FIG. 1D

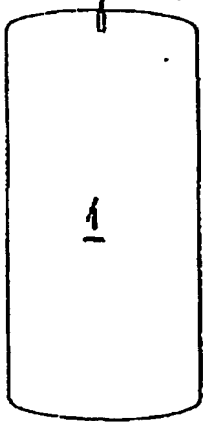

FIG. 1A

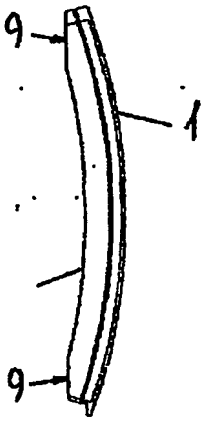

FIG. 1B

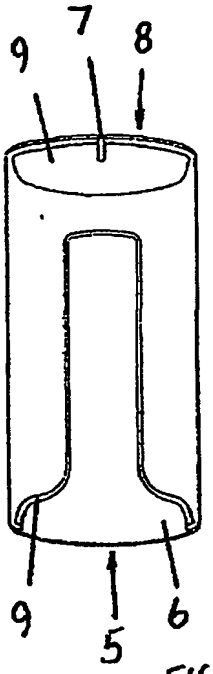

FIG. 1C

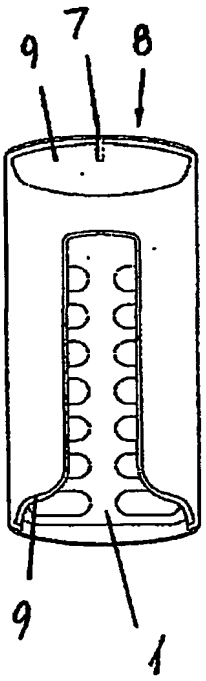

FIG. 1F

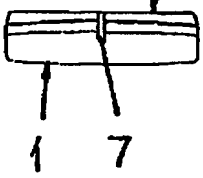

FIG. 1E

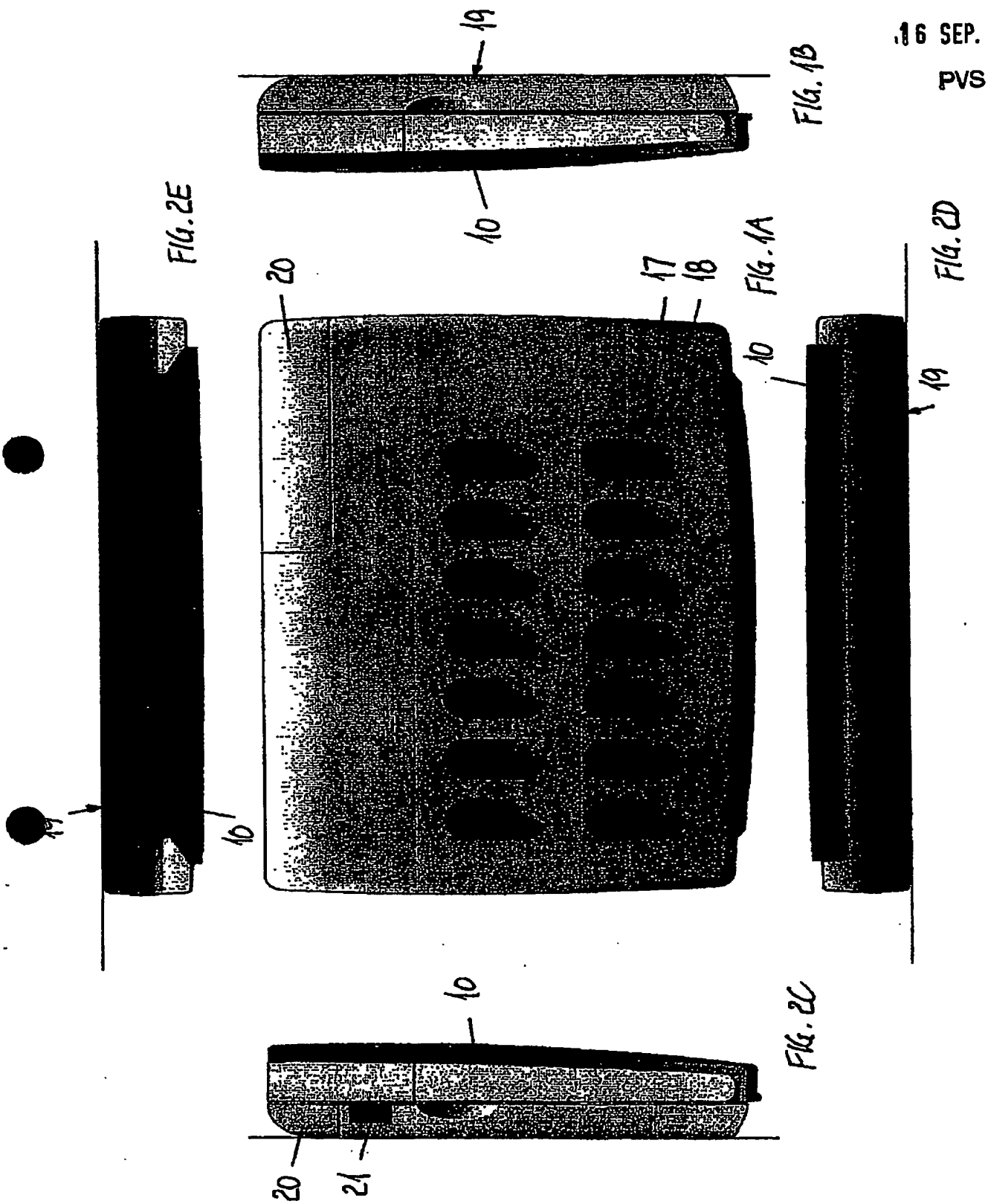

FIG. 1B
FIG. 2E
FIG. 1A
FIG. 2D
FIG. 2C

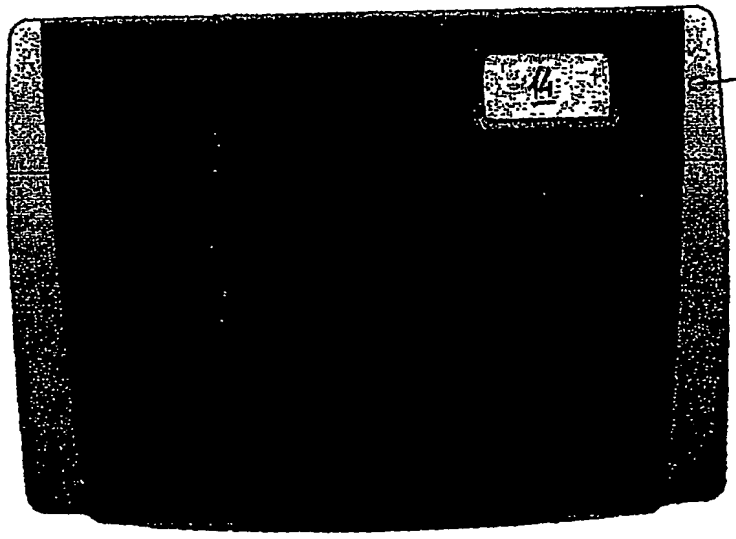

FIG. 2F

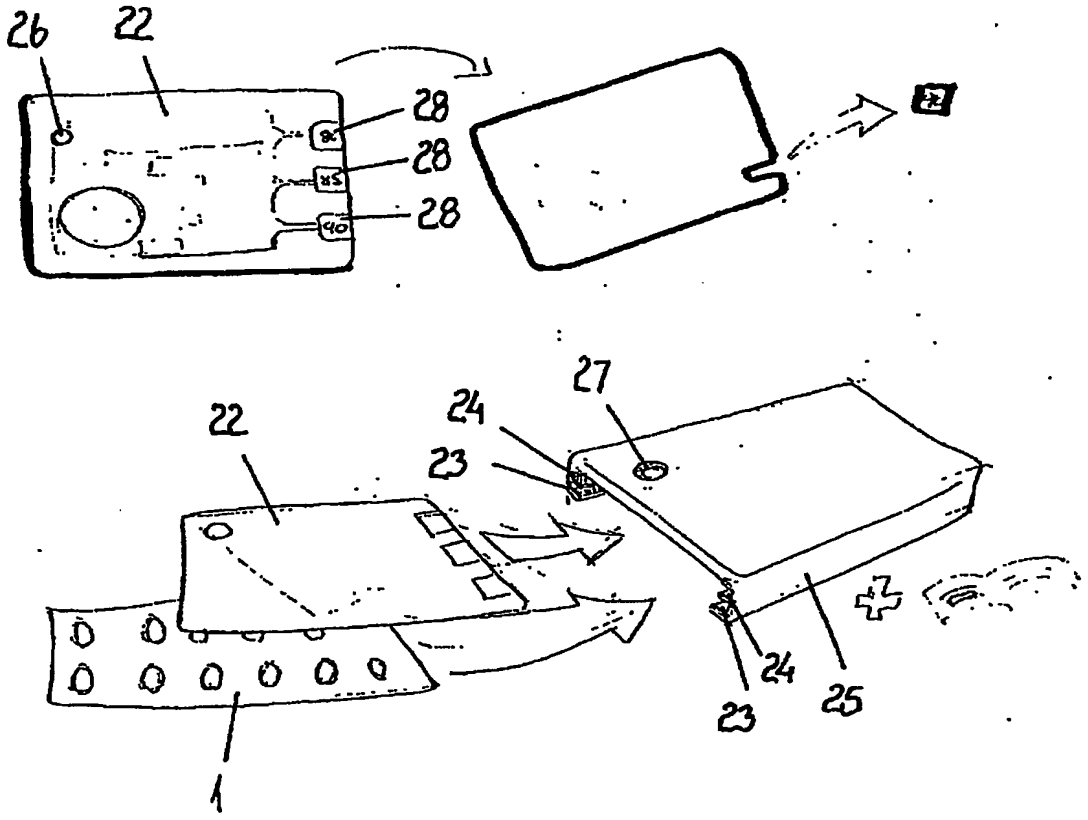

FIG. 3

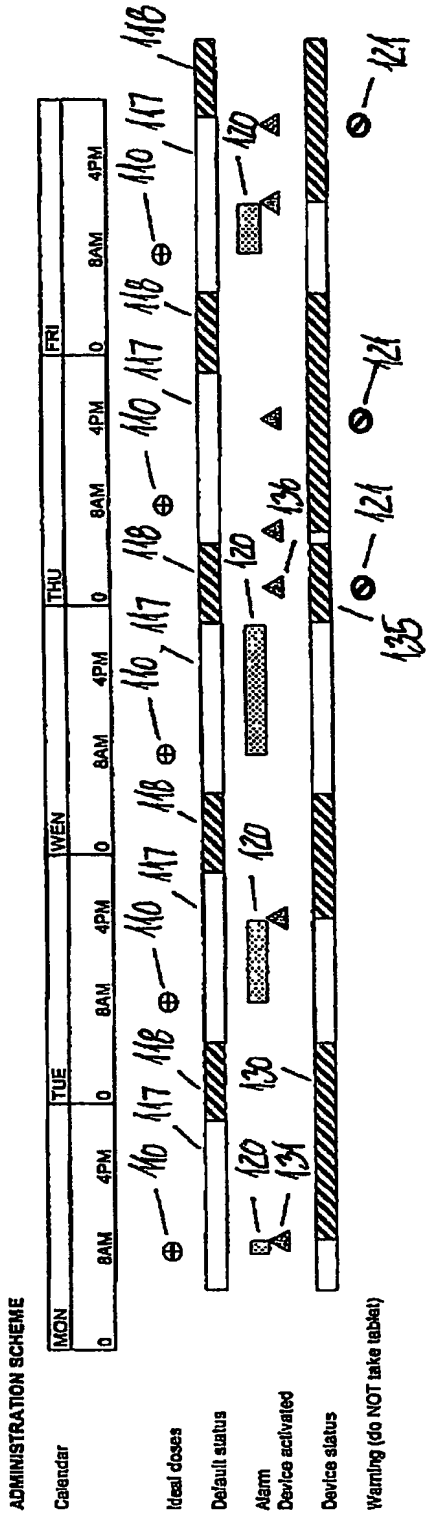

FIG. 4A

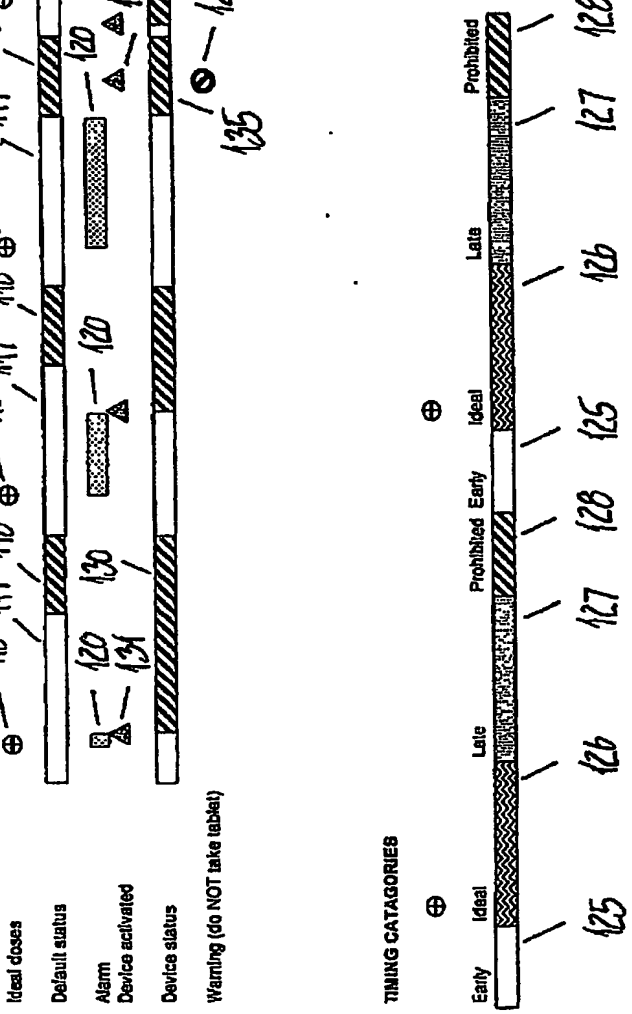

FIG. 4B

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16. september 2002
Ny dansk patentansøgning
Bang & Olufsen Medicom A/S
A device for administration of drugs
Vores ref: 31932 DK 02

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Patentansøgning

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2. Ansøgers fuldmægtigs referencenr.:
17763

3. International indleveringsdag: ☐ Kapitel I
Internationalt ansøgningsnr.: ☐ Kapitel II

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7. Opfindelsens benævnelse:

"Method of determining the quality of an AEP signal"

8. Prioritetspåstand(e): ☐ Flere prioritetspåstande på bagsiden

Dato	---	Land	---	Nr.	---
Dato		Land		Nr.	
Dato		Land		Nr.	

9. ☐ Ansøgningen omfatter deponering af en prøve af biologisk materiale, som angivet i patentlovens § 8a, stk.1.

10. ☐ Ansøgningen omfatter en sekvensliste.

11. ☐ Ansøgningen er fremkommet ved deling eller udskillelse.
Stamansøgningens nr.: Ansøgt løbedag:

13. ☐ Ansøgningen er tidligere indleveret pr. telefax den:

14. Dato og underskrift: Kbh., 13/3-02
LARSEN & BIRKEHOLM A/S
Skandinavisk Patentbureau
Ole Jagtboe

PA 2002 00377

1. Gebyrer:
☒ Ansøgningsgebyr
☐ Kravgebyr
☐ ITS-nyhedsundersøgelsesgebyr

12. Bilagsfortegnelse:
☒ fremmedsproget beskrivelse
☐ dansk beskrivelse i 1 ekspl.
☐ sammendrag i 1 ekspl.
☒ tegninger i 1 ekspl.
☐ prioritetsdokument
☐ fuldmagt
☐ overdragelsesdokument
☐
☐
Fig nr. 2C ønskes publiceret sammen med sammendraget.

15. Behandling af fremmedsproget ansøgning m.m. ønskes
☐ norsk
☐ svensk
☒ engelsk

Ansøgere fortsat

Ansøger (fulde navn og adresse):

Telefon: Telefax:

Ansøger (fulde navn og adresse):

Telefon: Telefax:

Opfindere fortsat

Opfinder (fornavn, efternavn, adresse):

Opfinder (fornavn, efternavn, adresse):

Opfinder (fornavn, efternavn, adresse):

Opfinder (fornavn, efternavn, adresse):

Prioritetspåstande fortsat

Dato	Land	Nr.
Dato	Land	Nr.
Dato	Land	Nr.
Dato	Land	Nr.
Dato	Land	Nr.
Dato	Land	Nr.

Vor ref.: 17763

Ansøger: Danmeter A/S

Method of determining the quality of an AEP signal

Method of determining the quality of an AEP signal

This invention relates to a method of determining the quality of signals which are indicative of the level of consciousness of a patient, said signals being determined by subjecting a patient to a number N of audio stimulus, and monitoring auditory evoked potentials (AEP) produced by the patient.

Such a method is disclosed in the published International patent application no. WO 01/74248.

According to this published application it is possible within a very short time to measure a reliable AEP signal by use of an index which is calculated from an autoregressive model with exogenous input.

A measuring apparatus for carrying out measurements of AEP signals is described in the Danish patent application no. PA 2001 00381, which was not published at the day of the filing of the present application.

Even though the method according to WO 01/74248 has shown good and reliable results it is not possible to evaluate the quality of the AEP signal. The AEP signal is an evoked electrical activity, embedded in EEG activity that is elicited in a neural pathway by acoustic sensory stimulus. The AEP is thus the synchronised response to the acoustic stimulus provided by a train of acoustic pulses.

A problem in the analysis of the AEP activity occurs when background activity, such as EEG, Electro Encephalogram activity and EMG, Electro Myogram, artefacts and the like are present.

There are many techniques such as averaging (linear or exponential) and filtering, ARX modelling, etc that are required to extract the AEP activity

from the background activity.

All these techniques are based on the AEP activity and the lack of synchronisation between the other activities that compound the background activity.

A new method according to the invention is based on an estimation of an SNR (signal to noise potential) based on the use of a previous AEP, as explained in more detail later.

The method according to the invention is defined in claim 1, and is characterised by the following steps:

a) estimation of a signal AAI_s by averaging a number of K synchronised measured successive segments of samples,

b) estimation of a signal AAI_u by averaging a number of K unsynchronised successive segments of samples

c) calculating the signal to noise ratio $SNR = AAI_s/AAI_u$,

where $AAI = \sum_{i=1}^{K} |x(i) - x(i+1)|$ and

x (i) are sample points in the interval i=1 to i=K

This SNR estimation is evaluated as a ratio of an averaged synchronous signal measure with the acoustic stimulus to an average asynchronous signal measure.

Thus the averaged synchronous signal is the estimated AEP, whereas the averaged asynchronous signal is the estimation of the background noise and how it affects the AEP extraction.

In other words the SNR estimation will provide valuable information about the quality of the AEP activity and its extraction. This information will allow a monitor to determine whether or not an AEP is present in the measured signal and whether the applied averaging is not sufficient to extract the AEP, and therefore increase averaging until the desired SNR is achieved.

An SNR close to 1 implies bad signal conditions, which means that both averaging processes, (linear exponential) synchronous as well as asynchronous are nearly equal, and therefore there is either a weak synchronisation or no synchronisation with the stimulus.

An insufficient averaging or the lack of evoked activity (which can be the case if the headphones that provide the stimulus are not placed properly on the patient) can produce a low SNR, such as around 1.

In order to further improve the quality of the SNR signal it is expedient if, as stated in claim 2, that a plurality N of SNR values are calculated, and that an averaged value of the plurality of SNR values is calculated according to the formula:

$$SNR = \frac{\sum_{i=1}^{N} SNR_i}{N} = \frac{\sum_{i=1}^{N}\left(\frac{syncrh.measure}{unsynch.measure_i}\right)}{N} = \frac{\sum_{i=1}^{N}\left(\frac{AAIs}{AAIu_i}\right)}{N},$$

in which

i = 1 to i = N denotes a plurality of sweeps.

In this way the inherent fluctuation of the unsynchronised process is decreased, and an even better SNR ratio obtained.

In order to estimate whether any sweeps are necessary to obtain a sufficiently good SNR, it is expedient if, as stated in claim 3, that a calculated SNR value is supplied to a control circuit together with a desired SNR value, and on the basis of a difference signal calculated as a difference between the calculated value and the desired value, the control circuit is adapted to calculate the amount of necessary sweeps.

In this way time can be saved since no unnecessary calculations/estimations are needed. In other words only the number of calculations reasonably to obtain a good SNR is satisfactory.

Finally, it is expedient if the method is carried as stated in claim 4, i. e. by using a difference signal that is fed to an input of a PID control circuit and fed from an output from the PID control circuit to an input of a circuit adapted to calculate a number N of sweeps, said number being fed to a circuit for starting an averaging process, and on the basis of this to estimate a new SNR value which is feed back as a new SNR value for calculating a new difference which is fed to the PID control circuit.

The invention will now be described in more detail with reference to the drawing, in which:

fig. 1 shows the signals for extracting the AEP (Auditory Evoked Potentials) and the time slots used for the calculations according to the invention,

fig. 2A shows an example of the signals in the synchronised averaging process at a different number of synchronised averaging

sweeps.

fig. 2B shows an example of the signals in the unsynchronised averaging process at a different number of unsynchronised averaging sweeps

fig. 2C shows the synchronised and the unsynchronised signals from an averaging process involving 256 sweeps, and

fig. 3 shows a block diagram of a circuit for use in carrying out the method according to the invention.

In figure 1, 2 denotes an acoustic signal which is delivered to a patient not shown under anaesthesia. This signal is in the form of a click or the like, having a duration of approximately 1 – 2 ms.
As can be seen from the figure, seven such signals are provided. In practice more than 10 or less than 50 are used.
1 denotes the response signal from the patient, whereas 3 denotes a segment or a time slot in which a plurality of K samples from the patient are detected, e.g. between 1 and 400 in each time slot, preferably about 100.
The signal 1 contains both evoked activity and bagground activity, such as EMG, EEG, etc.

It is further noted that a group of segments 4 is divided in a synchronised way, whereas another group of segments 5 is divided in an unsynchronised way.
From the drawing it will be seen that the unsynchronised segments 5 are distributed vs. time in a random manner.

Fig. 2 A shows an example of a plurality of signals, each of which has been subjected to a synchronised averaging process within a time slot 3, cf. fig.

1, and averaged with different pluralities of sweeps.
As will be seen, the shape of the signals is dependent on the plurality of sweeps used.
It is clear that when the plurality of sweeps used are increased, then the signal extraction is improved. For instance 256 sweeps yield good results.

In fig 2B, the averaging process is carried out in a way similar to that of fig. 2A, but in an unsynchronised random way.
It will be seen that when the plurality of sweeps used for the averaging process are increased, then the resulting signal is nearly constant, without leaving any signal extraction. For instance, this can be seen at the curve using 256 sweeps.

In fig 2C both signals extracted from the synchronised and unsynchronised process are shown, and in both cases created by using 256 sweeps,
In this situation the two signals are very different, and a measure related to the relation between the AAI_s and the $AA1_u$ will give a high SNR, and thus a high quality of the desired signal AEP.

In contrast to this, a low ratio will exist when no AEP synchronised activity signal exists, which is the case when the synchronised and the unsynchronised signals are very similar.

In order to calculate how many sweeps are necessary in order to obtain a sufficiently good SNR, the method can be carried out by use of the circuit in the form of a control loop shown in fig. 3.

This control loop consists of a PID (Proportional Integral Differential) regulator 15 having an input 14, to which the output from a summing circuit 14 is fed.
Two signals are fed to the input of the summing circuit namely a desired

value 12 representing a desired SNR and an actual value of SNR taken from a equipment not shown.

The signal is fed from the output of the PID regulator to a calculation circuit 16, which on the basis of a linear or exponential calculation estimates a number N representing a plurality of necessary sweeps.

An averaging process is initiated from circuit 16 on basis of the calculated N in 18, and an estimation of SNR is carried out in circuit 18.

The so calculated SNR is again fed back to the summing circuit, and new values are fed to the control loop via the summation circuit in order to estimate a new SNR, perhaps on the basis of a smaller or higher N.

In this way it is possible to survey the SNR in order to estimate the necessary calculations needed for obtaining a sufficiently high value of the SNR and thereby a good quality of the AEP.

CLAIMS

1. A method of determining the quality of signals which are indicative of the level of consciousness of a patient, said signals being determined by subjecting a patient to a number N of audio stimulus, and monitoring auditory evoked potentials (AEP) produced by the patient comprising the steps of

   d) estimation of a signal AAI_s by averaging a number of K synchronised measured successive segments of samples,

   e) estimation of a signal AAI_u by averaging a number of K unsynchronised successive segments of samples

   f) calculating the signal to noise ratio SNR = AAI_s/AAI_u.,

   where AAI = $\sum_{i=1}^{K}|x(i)-x(i+1)|$ and

   x (i) are sample points in the interval i=1 to I=K

2. A method according to claim 1, **characterised in** that a plurality N of SNR values are calculated, and in that an averaged value of the plurality of SNR values is calculated according to the formula:

$$SNR=\frac{\sum_{I=1}^{N}SNR_I}{N}=\frac{\sum_{i=1}^{N}\left(\frac{syncrh.measure}{unsynch.measure_i}\right)}{N}=\frac{\sum_{i=1}^{N}\left(\frac{AAIs}{AAIu_i}\right)}{N}$$, where

I = 1 to I =N denotes a plurality of sweeps.

3. A method according to claim 2, **characterised in** that a calculated SNR value is supplied to a control circuit together with a desired SNR value, and on the basis of a difference signal calculated as a difference between the calculated value and the desires value, the control circuit is adapted to calculate the amount of necessary calculations of SNR values.

4. A method according to claim 3 **characterised in** that the difference signal is fed to an input of a PID control circuit and fed from an output from the PID control circuit to an input of a circuit adapted to calculate a number N of sweeps, said number being fed to a circuit for starting an averaging process, and on the basis of this to estimate a new SNR value which is fed back as a new SNR value for calculating a new difference which is fed to the PID control circuit.

ABSTRACT

In a method of determining the quality of AEP signals, which are indicative of the level of consciousness of a patient, a signal to noise ratio SNR is calculated on the basis of calculation of a ratio of a signal AAI_s to a signal AAI_u, where the signal AAI_s is calculated by averaging a number of N synchronised measured successive segments of samples in response to N audio stimulus, and where the signal AAI_u is calculated by averaging a number of N unsynchronised measured successive segments of samples in response to the same N audio stimulus.
In this way the quality of a measured AEP signal is provided.

If the calculated value of the SNR is 1, or even lower, then the quality of the AEP is low.
However, if the calculated value of the SNR is high, then a good quality of the AEP is obtained.

In order to limit the amount of calculations necessary to obtain a high SNR and thereby a good AEP, a use of a circuit for carrying out the method is provided, said circuit having a controlled loop, inter alia comprising a PID regulator which, on the basis of a given calculated SNR value and a desired SNR value, can estimate to what degree calculations are needed in order to obtain a sufficiently high SNR and thereby a good quality of the AEP.

(Fig. 2C)

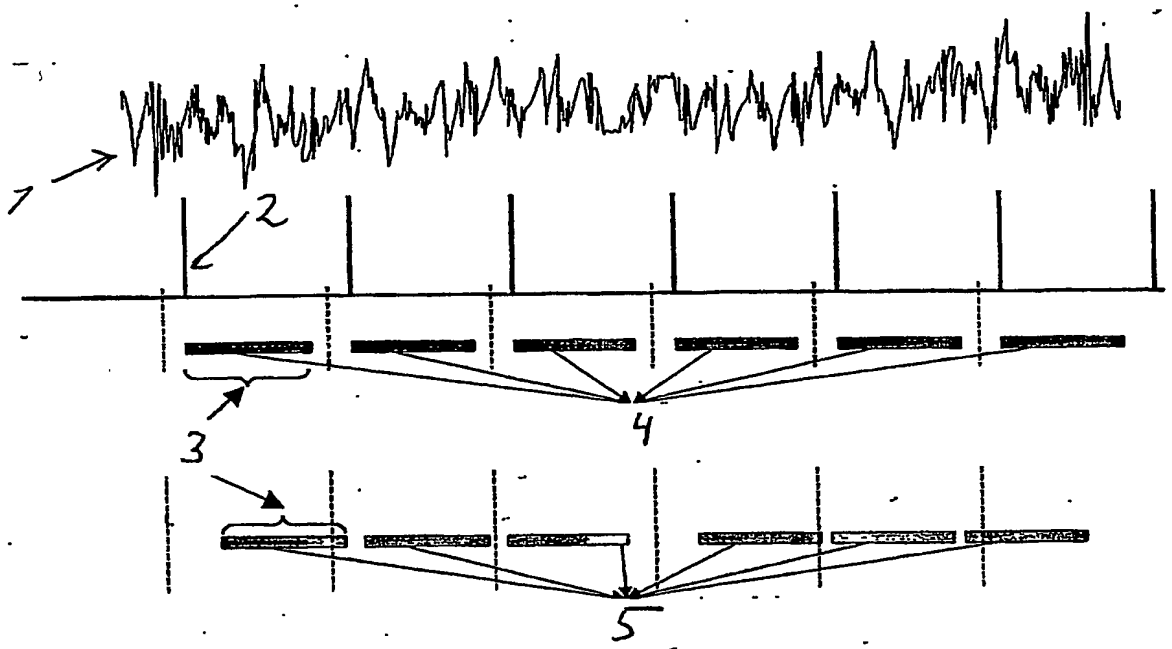

Fig 1

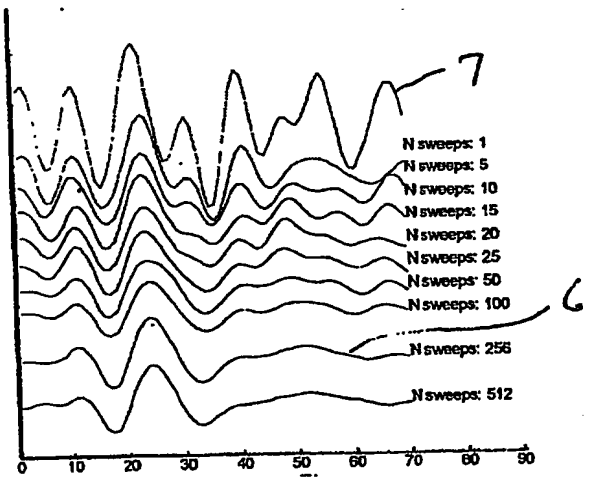

Fig. 2A

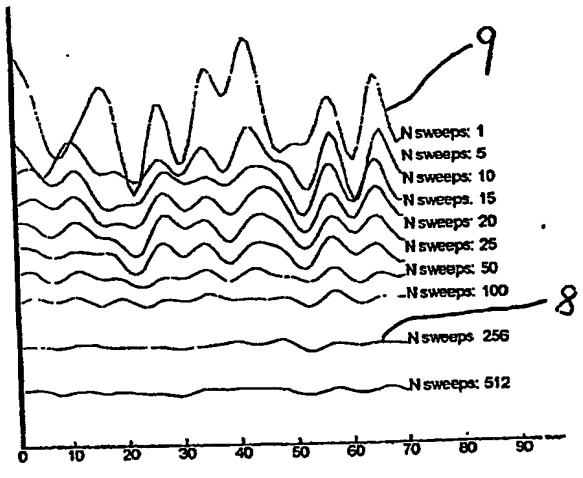

Fig 2B

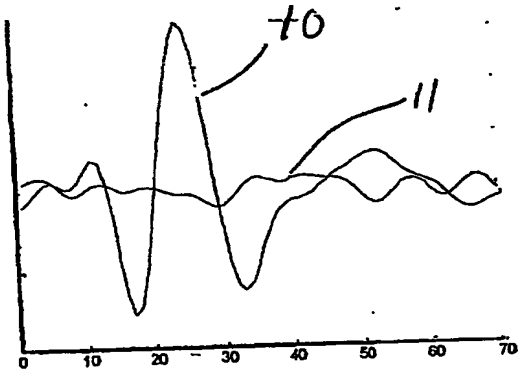

Fig 2C

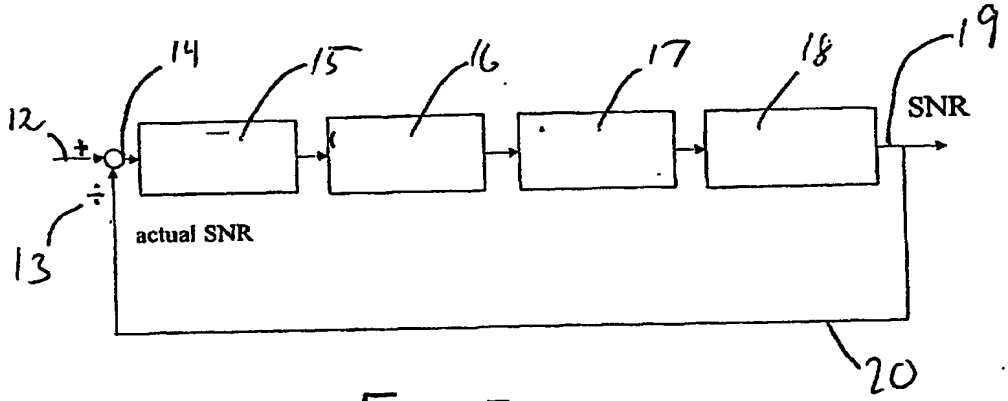

Fig 3